

What is claimed is:

1. A transmission bandwidth control device for controlling a transmission route for a flow in a network, comprising:

- 5 a statistical information collecting unit for collecting pieces of statistical information from respective routers connected to the network;
a network information database for storing the statistical information collected;
- 10 a user request processing unit for accepting and processing a flow forwarding request from a user terminal;
a route control unit for searching for a route corresponding to the request from the user terminal
- 15 by referring to the network information database;
a load sharing control unit for executing such a load sharing process as to generate router setting information for sharing a transmission load of the network by referring to the network information
- 20 database; and
a router control unit for setting a router based on the route information determined by the route control unit and on the router setting information generated by the load sharing control unit.

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2. A transmission bandwidth control device according to Claim 1, wherein the route control unit

includes quality guaranteed route searching module
searching for quality guaranteed route information
corresponding to the forwarding request for the
forwarding quality guaranteed flow by referring to
5 link statistical information concerning links between
the respective routers from the network information
database and quality non-guaranteed route searching
module searching for quality non-guaranteed route
information corresponding to the forwarding request
10 for the forwarding quality non-guaranteed flow, by
referring to link statistical information concerning
links between the respective routers from the network
information database, the load sharing control unit
executes the load sharing process by referring to the
15 quality guaranteed route information and the quality
non-guaranteed route information, and the router
control unit sets the quality guaranteed route and
the quality non-guaranteed route in accordance with
the searched quality guaranteed route information and
20 quality non-guaranteed route information.

3. A transmission bandwidth control device
according to Claim 2, further comprising a load
judging unit for judging whether or not a load state
25 of a path is equal to or smaller than the threshold
value by referring to the link statistical
information, when the load state of the path is equal

to or smaller than the threshold value, the quality
guaranteed route searching means searches for the
quality guaranteed route information, the load
sharing control unit executes the load sharing
5 process by referring to the quality guaranteed route
information, and the router control unit sets the
quality guaranteed route in accordance with the
quality guaranteed route information.

10 4. A transmission bandwidth control device
according to Claim 1, wherein the load sharing
control unit executes the load sharing process at an
interval of a predetermined period.

15 5. A transmission bandwidth control device
according to Claim 2, wherein the quality guaranteed
route searching means searches for a single piece of
route information that meets a requested quality as
the quality guaranteed route, the quality non-
20 guaranteed route searching means searches for plural
pieces of route information as the quality non-
guaranteed routes, and the router control unit sets a
plurality of routes related to the quality non-
guaranteed routes in accordance with the plural
25 pieces of route information.

6. A transmission bandwidth control device

according to Claim 2, wherein the quality non-guaranteed route searching means searches for a single piece of route information as the quality non-guaranteed route, the quality guaranteed route
5 searching means searches for plural pieces of route information as the quality guaranteed routes, and the router control unit sets a plurality of routes related to the quality guaranteed routes in accordance with the plural pieces of route
10 information.

7. A transmission bandwidth control device according to Claim 5, wherein the quality guaranteed route searching means selects such a route as to
15 minimize a cross-over hop count in the network, and the quality non-guaranteed route searching means selects such a route as to minimize the network cross-over hop count.

20 8. A transmission bandwidth control device according to Claim 6, wherein the quality guaranteed route searching means selects such a route as to minimize a cross-over hop count in the network, and the quality non-guaranteed route searching means
25 selects such a route as to minimize the network cross-over hop count.

9. A transmission bandwidth control device
according to Claim 5, wherein the quality guaranteed
route searching means selects such a route as to
minimize a cross-over hop count in the network, and
5 the quality non-guaranteed route searching means
selects such a route as to maximize a residual
bandwidth in the network.

10. A transmission bandwidth control device
10 according to Claim 6, wherein the quality guaranteed
route searching means selects such a route as to
minimize a cross-over hop count in the network, and
the quality non-guaranteed route searching means
selects such a route as to maximize a residual
15 bandwidth in the network.

11. A transmission bandwidth control device
according to Claim 5, wherein the quality guaranteed
route searching means selects such a route as to
20 maximize a residual bandwidth in the network, and the
quality non-guaranteed route searching means selects
such a route as to minimize the cross-over hop count
in the network.

25 12. A transmission bandwidth control device
according to Claim 6, wherein the quality guaranteed
route searching means selects such a route as to

maximize a residual bandwidth in the network, and the quality non-guaranteed route searching means selects such a route as to minimize the cross-over hop count in the network.

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13. A transmission bandwidth control device according to Claim 5, wherein the quality guaranteed route searching means selects such a route as to maximize a residual bandwidth between a network
10 ingress node and a network egress node in the network, and the quality non-guaranteed route searching means selects such a route as to maximize a residual bandwidth between the network ingress node and the network egress node in the network.

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14. A transmission bandwidth control device according to Claim 6, wherein the quality guaranteed route searching means selects such a route as to maximize a residual bandwidth between a network
20 ingress node and a network egress node in the network, and the quality non-guaranteed route searching means selects such a route as to maximize a residual bandwidth between the network ingress node and the network egress node in the network.

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15. A transmission bandwidth control device according to Claim 5, wherein the quality guaranteed

route searching means selects such a route as to minimize a residual bandwidth between the network ingress node and the network egress node in the network, and the quality non-guaranteed route

5 searching means selects such a route as to minimize a cross-over hop count between the network ingress node and the network egress node in the network.

16. A transmission bandwidth control device
10 according to Claim 6, wherein the quality guaranteed route searching means selects such a route as to minimize a residual bandwidth between the network ingress node and the network egress node in the network, and the quality non-guaranteed route
15 searching means selects such a route as to minimize a cross-over hop count between the network ingress node and the network egress node in the network.

17. A transmission bandwidth control device
20 according to Claim 5, wherein the quality guaranteed route searching means selects such a route as to minimize a residual bandwidth between the network ingress node and the network egress node in the network, and the quality non-guaranteed route
25 searching means selects such a route as to maximize a residual bandwidth between the network ingress node and the network egress node in the network.

18. A transmission bandwidth control device according to Claim 6, wherein the quality guaranteed route searching means selects such a route as to
5 minimize a residual bandwidth between the network ingress node and the network egress node in the network, and the quality non-guaranteed route searching means selects such a route as to maximize a residual bandwidth between the network ingress node
10 and the network egress node in the network.

19. A transmission bandwidth control device according to Claim 7, wherein the quality guaranteed route searching means when there exist a plurality of
15 such routes as to minimize the cross-over hop count between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth therein between the network ingress node and the network egress node or such a
20 route as to minimize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to minimize the cross-over hop count
25 between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth therein between the network

ingress node and the network egress node.

20. A transmission bandwidth control device
according to Claim 8, wherein the quality guaranteed
5 route searching means when there exist a plurality of
such routes as to minimize the cross-over hop count
between the network ingress node and the network
egress node, selects such a route as to maximize a
residual bandwidth therein between the network
10 ingress node and the network egress node or such a
route as to minimize a residual bandwidth therein
between the network ingress node and the network
egress node, and the quality non-guaranteed route
searching means when there exist a plurality of such
15 routes as to minimize the cross-over hop count
between the network ingress node and the network
egress node, selects such a route as to maximize a
residual bandwidth therein between the network
ingress node and the network egress node.

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21. A transmission bandwidth control device
according to Claim 9, wherein the quality guaranteed
route searching means when there exist a plurality of
such routes as to minimize the cross-over hop count
25 between the network ingress node and the network
egress node, selects such a route as to maximize a
residual bandwidth therein between the network

ingress node and the network egress node or such a route as to minimize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route
5 searching means when there exist a plurality of such routes as to maximize the residual bandwidth between the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count therein between the network ingress node and
10 the network egress node.

22. A transmission bandwidth control device according to Claim 10, wherein the quality guaranteed route searching means when there exist a plurality of
15 such routes as to minimize the cross-over hop count between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth therein between the network ingress node and the network egress node or such a
20 route as to minimize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to maximize the residual bandwidth between
25 the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count between the network ingress node and the

network egress node.

23. A transmission bandwidth control device according to claim 11, wherein the quality guaranteed
5 route searching means when there exist a plurality of routes as to maximize the residual bandwidth between the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count therein between the network ingress node and
10 the network egress node or such a route as to minimize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to minimize
15 the cross-over hop count between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth therein between the network ingress node and the network egress node.

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24. A transmission bandwidth control device according to claim 12, wherein the quality guaranteed route searching means when there exist a plurality of such routes as to maximize the residual bandwidth
25 between the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count therein between the network

ingress node and the network egress node or such a route as to minimize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route
5 searching means when there exist a plurality of such routes as to minimize the cross-over hop count between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth therein between the network
10 ingress node and the network egress node.

25. A transmission bandwidth control device according to Claim 13, wherein the quality guaranteed route searching means when there exist a plurality of
15 such routes as to maximize the residual bandwidth between the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count between the network ingress node and the network egress node or such a route as to
20 minimize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to maximize the residual bandwidth therein between the network
25 ingress node and the network egress node, selects such a route as to minimize a cross-over hop count between the network ingress node and the network

egress node.

26. A transmission bandwidth control device
according to Claim 14, wherein the quality guaranteed
5 route searching means when there exist a plurality of
such routes as to maximize the residual bandwidth
between the network ingress node and the network
egress node, selects such a route as to minimize a
cross-over hop count between the network ingress node
10 and the network egress node or such a route as to
minimize a residual bandwidth therein between the
network ingress node and the network egress node, and
the quality non-guaranteed route searching means when
there exist a plurality of such routes as to maximize
15 the residual bandwidth between the network ingress
node and the network egress node, selects such a
route as to minimize a cross-over hop count between
the network ingress node and the network egress node.

20 27. A transmission bandwidth control device
according to Claim 15, wherein the quality guaranteed
route searching means when there exist a plurality of
such routes as to minimize the residual bandwidth
between the network ingress node and the network
25 egress node, selects such a route as to maximize a
residual bandwidth therein between the network
ingress node and the network egress node or such a

route as to minimize a cross-over hop count between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to
5 minimize the cross-over hop count between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth between the network ingress node and the network egress node.

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28. A transmission bandwidth control device according to Claim 16, wherein the quality guaranteed route searching means when there exist a plurality of such routes as to minimize the residual bandwidth
15 therein between the network ingress node and the network egress node, selects such a route as to maximize a residual bandwidth therein between the network ingress node and the network egress node or such a route as to minimize a cross-over hop count
20 between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to minimize the cross-over hop count between the network ingress node and the network
25 egress node, selects such a route as to maximize a residual bandwidth therein between the network ingress node and the network egress node.

29. A transmission bandwidth control device according to claim 17, wherein the quality guaranteed route searching means when there exist a plurality of
5 such routes as to minimize the residual bandwidth between the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count therein between the network ingress node and the network egress node or such a
10 route as to maximize a residual bandwidth therein between the network ingress node and the network egress node, and the quality non-guaranteed route searching means when there exist a plurality of such routes as to maximize the residual bandwidth between
15 the network ingress node and the network egress node, selects such a route as to minimize a cross-over hop count between the network ingress node and the network egress node.

20 30. A transmission bandwidth control device according to claim 18, wherein the quality guaranteed route searching means when there exist a plurality of such routes as to minimize the residual bandwidth between the network ingress node and the network
25 egress node, selects such a route as to minimize a cross-over hop count therein between the network ingress node and the network egress node or such a

route as to maximize a residual bandwidth therein
between the network ingress node and the network
egress node, and the quality non-guaranteed route
searching means when there exist a plurality of such
5 routes as to maximize the residual bandwidth between
the network ingress node and the network egress node,
selects such a route as to minimize a cross-over hop
count between the network ingress node and the
network egress node.

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31. A transmission bandwidth control device
according to Claim 5, wherein at least one of the
quality guaranteed route searching means and the
quality non-guaranteed route searching means, at a
15 point of time when selecting a route afresh, switches
over a route selection system.

32. A transmission bandwidth control device
according to Claim 6, wherein at least one of the
20 quality guaranteed route searching means and the
quality non-guaranteed route searching means, at a
point of time when selecting a route afresh, switches
over a route selection system.

25 33. A transmission bandwidth control device according
to Claim 2, wherein the quality non-guaranteed route
searching means, when selecting a route for a flow

that does not guarantee a forwarding quality, a ratio
of a remaining bandwidth which is a result of
subtracting a bandwidth for a flow that guarantees
the forwarding quality and for the flow that does not
5 guarantee the forwarding quality from the entire link
as a link's physical bandwidth, with respect to the
entire link bandwidth, is used as a link's available
bandwidth.

10 34. A transmission bandwidth control device
according to Claim 2, wherein the quality non-
guaranteed route searching means, when selecting a
route for a flow that does not guarantee a forwarding
quality, a remaining bandwidth which is a result of
15 subtracting a bandwidth for a flow that guarantees
the forwarding quality and for the flow that does not
guarantee the forwarding quality from the entire link
as a link's physical bandwidth, is used as a link's
available bandwidth.

20 35. A transmission bandwidth control device
according to Claim 2, wherein the quality non-
guaranteed route searching means, when selecting a
route for a flow that does not guarantee a forwarding
25 quality, uses a ratio of a remaining bandwidth, as a
link's residual bandwidth, which is a result of
subtracting the bandwidth for the flow that does not

guarantee the forwarding quality from a link
bandwidth as link's physical bandwidth ,with respect
to a bandwidth unreserved for the flow that
guarantees the forwarding quality.

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36. A transmission bandwidth control device
according to Claim 2, wherein the quality guaranteed
route searching means, when selecting a route for a
flow that guarantees a forwarding quality, uses a
10 remaining bandwidth, as a link's residual bandwidth,
which is a result of subtracting the bandwidth for
the forwarding quality guaranteed flow from a
bandwidth utilizable for the forwarding quality
guaranteed flow.

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37. A transmission bandwidth control device
according to Claim 2, wherein the quality guaranteed
route searching means, when selecting a route for a
flow that guarantees a forwarding quality, uses a
20 ratio of a remaining bandwidth, as a link's residual
bandwidth, which is a result of subtracting a
bandwidth for the forwarding quality guaranteed flow
from a bandwidth utilizable for the forwarding
quality guaranteed flow , with respect to the
25 bandwidth utilizable for the forwarding quality
guaranteed flow.

38. A transmission bandwidth control device according to Claim 34, wherein the quality non-guaranteed route searching means, when accepting a request for a service, determines a route from a topology taking allowances for the entire link.

39. A transmission bandwidth control device according to Claim 36, wherein the quality guaranteed route searching means, when accepting a request for a service, determines a route from a topology taking allowances for only a link of which a link's residual bandwidth is equal to or larger than the request bandwidth.

40. A transmission bandwidth control device according to Claim 5, wherein the quality guaranteed route searching means when accepting a request for a service that guarantees a forwarding quality, makes a selection from a topology connecting links of which a using bandwidth for a service that does not guarantee the forwarding quality does not exceed a threshold value and of which a residual bandwidth obtained by a calculation of a link's using bandwidth is equal to or larger than the request bandwidth.

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41. A transmission bandwidth control device according to Claim 5, further comprising module

referring to a threshold value related to a path
using ratio, wherein the load sharing control unit,
in the case of exceeding the threshold value related
to the using ratio, shifts the flow that does not
5 guarantee the forwarding quality to a detour route.

42. A transmission bandwidth control device
according to Claim 5, further comprising module
referring to a threshold value related to a ratio at
10 which an actual using bandwidth for a service that
does not guarantee the forwarding quality occupies a
bandwidth left by subtracting a bandwidth ensured for
the service that guarantees the forwarding quality in
a path, wherein the router control unit, when the
15 ratio of the actual using bandwidth exceeds the
threshold value, shifts the flow that does not
guarantee the forwarding quality to an detour route.

43. A transmission bandwidth control device
20 according to Claim 5, wherein the quality non-
guaranteed route searching means further includes
module referring to a threshold value related to a
ratio at which an estimated range of the using
bandwidth for the service that does not guarantee the
25 forwarding quality occupies a bandwidth left by
subtracting a bandwidth ensured for such a service as
to guarantee the forwarding quality in the path by

accepting the estimated range of the using bandwidth
when accepting a request for the service that does
not guarantee the forwarding quality, and the router
control unit, when the ratio exceeds the threshold
5 value, shifts the flow that does not guarantee the
forwarding quality to the detour route.

44. A transmission bandwidth control device
according to Claim 6, wherein at least one of the
10 quality guaranteed route searching means and the
quality non-guaranteed route searching means, when
accepting a request for a service that guarantees a
forwarding quality and a request for a service that
does not guarantee the forwarding quality, selects a
15 route in accordance with an individually
predetermined route selection policy, and, when
accepting the request for the service that guarantees
the forwarding quality, determines a route from a
topology taking allowances for a link of which a
20 link's residual bandwidth is equal to or larger than
the request bandwidth and for a link where a ratio at
which a quality non-guaranteed traffic occupies the
link does not exceed a predetermined reference value.

25 45. A transmission bandwidth control device
according to Claim 6, wherein the quality guaranteed
route searching means when accepting a request for a

service that guarantees a forwarding quality selects a route from a topology connecting links of which a using bandwidth for a service that does not guarantee the forwarding quality does not exceed a set
5 threshold value and of which a residual bandwidth obtained by a calculation of the link's using bandwidth is equal to or larger than the request bandwidth.

10 46. A transmission bandwidth control device according to Claim 6, wherein the load sharing control unit further includes module referring to a threshold value related to the path using ratio, and, when the using ratio is less than the threshold value,
15 the router control unit, when there is a residual bandwidth for accommodating the quality guaranteed flow and there exists other less optimal path, shifts the quality guaranteed flow to the path of which the using ratio is less than the threshold value from the
20 less optimal path.

 47. A transmission bandwidth control device according to Claim 6, wherein the load sharing control unit further includes module referring to a
25 threshold value related to a bandwidth ensured for the service that guarantees the forwarding quality in the path, and, when the using ratio is less than the

threshold value, the router control unit, when there is a residual bandwidth for accommodating the quality guaranteed flow and there exists other less optimal path, shifts the quality guaranteed flow to an
5 optimal path having the residual bandwidth.

48. A transmission bandwidth control device according to Claim 6, wherein the load sharing control unit further includes module referring to a
10 threshold value related to ratio at which a bandwidth ensured for the service that guarantees the forwarding quality occupies a bandwidth utilizable for the quality guaranteed service in the path, and, when the ratio is less than the threshold value, the
15 router control unit, when there is a residual bandwidth for accommodating the quality guaranteed flow and there exists other less optimal path, shifts the quality guaranteed flow to an optimal path having the residual bandwidth.

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49. A transmission bandwidth control device according to Claim 6, wherein the load sharing control unit further includes module referring to a
threshold value related to an actual using bandwidth
25 for the service that guarantees the forwarding quality in the path, and, when the actual using bandwidth is less than the threshold value, the

router control unit, when there is a residual
bandwidth for accommodating the quality guaranteed
flow and there exists other less optimal path, shifts
the quality guaranteed flow to an optimal path having
5 the residual bandwidth.

50. A transmission bandwidth control device
according to Claim 6, wherein the load sharing
control unit further includes module referring to a
10 threshold value related to a ratio at which an actual
using bandwidth for the service that guarantees the
forwarding quality occupies a bandwidth utilizable
for the quality guaranteed service in the path, and,
when the ratio is less than the threshold value, the
15 router control unit, when there is a residual
bandwidth for accommodating the quality guaranteed
flow and there exists other less optimal path, shifts
the quality guaranteed flow to an optimal path having
the residual bandwidth.

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51. A transmission bandwidth control device
according to Claim 6, wherein the load sharing
control unit, in a state where a plurality of paths
are set up for the flow that guarantees the
25 forwarding quality, in the case of being unable to
ensure a request bandwidth for the quality guaranteed
service due to a small residual bandwidth but in the

case of being able to ensure the request bandwidth by shifting the existing flows accommodated in the plurality of paths, accepts a request by effecting a flow shift.

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52. A transmission control method of controlling a transmission route for a flow in a network, comprising:

- collecting pieces of statistical information from
10 respective routers connected to the network;
- accepting a flow forwarding request from a user terminal;
- quality-guaranteed-route searching for quality
guaranteed route information corresponding to the
15 request for the forwarding the flow that guarantees a forwarding quality by referring to the network statistical information and the request from the user terminal;
- quality-non-guaranteed-route searching for a quality
20 non-guaranteed route corresponding to the request for forwarding the flow that does not guarantee the forwarding quality by referring to the network statistical information and the request from the user terminal;
- 25 executing such a load sharing process as to generate router setting information for sharing a transmission load of the network by referring to at least one of

the network statistical information the quality
guaranteed route information and quality non-
guaranteed route information; and

5 setting a router based on the route information, the
router setting information, the quality guaranteed
route information and the quality non-guaranteed
route information.

53. A transmission bandwidth control device
10 according to Claim 2, further comprising a congestion
judging unit for judging by referring to the link
statistical information whether a load state of the
path falls into a congestion or not, wherein when the
load state of the path falls into the congestion, the
15 quality non-guaranteed route searching means searches
for quality non-guaranteed route information, the
load sharing control unit executes the load sharing
process by referring to the quality guaranteed route
information and the quality non-guaranteed route
20 information, and the router control unit sets a
quality non-guaranteed route in accordance with the
quality non-guaranteed route information.